Claim 38 A method as claimed in claim 20, 21 or 22 wherein said varying delay amount of step a) is automatically adjusted in response to comparison of said feedback signal and said talent signal in undelayed form, and said level of step b) is automatically adjusted in response to said mix minus signal and said talent signal in delayed form.

Claim 39 A method as claimed in claim 20, 21 or 22 wherein said delaying of step a) include pitch correction in order that the pitch of said talent signal remains constant as said delay is changed.

COMMENTS

Applicant has added method claims herein to round out coverage of the invention.

Applicant encloses herewith UK Patent Application GB2269968A by Kirby et al. for the examiner's review. Applicant also encloses a copy of the paper by C.D. Kuglin and D.C. Hines "THE PHASE CORRELATION IMAGE ALIGNMENT METHOD" IEEE International conference on Cybernetics & Society (September 1975) :163-165, (hereinafter Kuglin). Applicant has been informed that there is a PCT version of this application: PCT/GB93/01738.

The Kuglin paper is referred to in The Kirby application. The paper discusses a method of accurately performing registration of fixed but displaced images, particularly in correlating

displaced aerial photographs. Such registration capabilities are useful in satellite, balloon and aircraft reconnaissance where there is a need to match images taken at different times or positions.

The Kirby application shows a device which is directed to the same problem as the instant invention, however there are several distinct and patentable differences in the way these two inventions operate.

The Kirby application shows a system for attenuating an unwanted signal 12 (Fig. 1) which is contained in a mixed signal 14. It is noted from the description that Kirby's unwanted signal 12 is similar to 10 of the instant application, and Kirby's mixed signal is the "off-air programme" (page 1, line12) similar to 18 of the instant application, at least in as much as applicant describes that the feedback signal is a program like signal which may be the off air signal. For example at page 6, line 3 from bottom of the instant application, the talent signal is mixed with the other electronic signal into the feedback signal.

It is noted that Kirby does not mention the use of his invention for several other purposes taught in the instant application, for example where the feedback signal 18 is a separate IFB signal rather than the program signal, such as shown being transmitted from 6 (Figure 1) or with radio production stations as suggested on page 6.

Kirby takes the steps of measuring the delay between the unwanted signal 12 and mixed signal 14 with delay measuring system 10, and then controls the two variable delays 21 and 22 (abstract).

While Kirby does recognize that the relative delay of the mixed and unwanted signals may be varying (page 2, ¶4) there is no mention or suggestion that the delay measurement system operates continuously or repeatedly, or that the delays 21 and 22 be adjusted continuously or repeatedly in response to changing delay.

The description of how the Delay Measuring System 10 operates is referenced to an image correlation paper at lines 4-11 of page 4. This paper is attached hereto for the examiner's review. It is unclear to applicant how this paper teaches, suggests, or is even remotely related to the need to measure delay of two similar audio signals.

The Kuglin paper operates with two NxN element fixed images, performing two dimensional matrix operations (page 164, 5th ¶, #1-4.). Applicant finds no suggestion of how this two dimensional, fixed time image algorithm could be modified for use with one dimensional continuous time audio signals, much less how it would find use at some point in time to determine the relative delay of two continuous audio signals as Kirby suggests. Neither Kirby nor Kuglin make any suggestions or shed any light on this problem.

Given that the Kuglin's algorithm is a fixed time application, i.e. it operates on two fixed images, it is believed that it has no suggestion for use with continuous signals such as audio. Even assuming for the sake of argument that Kuglin might somehow be applicable to audio, at most it would only be applicable to determining some relative characteristic at a single point in time, rather than continuously.

Kirby teaches away from the use of a continuously operating delay measurement and adjustment as will be described below.

It is noted that Kirby always uses variable delay 21 in his invention, the delay being required because of the particular way the adaptive cancellation circuit 30 accommodates changing relative delays of the mixed and unwanted signals. It is suggested to combine delays 21, 22 and 36 in a "single area of memory" (last ¶ of page 6).

Starting at page 4, line 11 Kirby states that the delays 21 and 22 are adjusted to co-time the unwanted and mixed signals. Kirby states at lines 11-16 "The measurement of delay <u>is then used</u> to control two audio delaying devices ··· in order to co-time <u>approximately</u> the two signals" (emphasis added). "After being co-timed ··· [the signals] are applied to an adaptive cancellation circuit 30". This description of the step by step operation; first measure delay, then adjust delay, then apply signals to adaptive cancellation, teaches away from a continuous

delay measure and adjust which is taught in applicant's invention, for example with respect to the description of Figure 3 on page 15. Further, Kirby does not suggest that delay 21 is ever unnecessary for this operation.

At line 18 Kirby states that circuit 30 automatically corrects for any remaining small delays between the signals. It is apparent from the subsequent description by Kirby that the resolution and control of Kirby's delays 21 and 22 is insufficient to place and keep the two signals in close enough timing for his circuit 30 to perform the cancellation without the additional delay capability which "corrects for any remaining small delays between the signals". The need for the adaptive cancellation circuit 30 to compensate for such additional delays is especially critical when the relative delay between 14 and 12 is changing.

Kirby utilizes his delay 21 to allow a shorter filter 32 to be used in the adaptive canceler 30 (page 5, lines 5-9), thus both delays 21 and 22 are necessary and important parts of the invention. Kirby further teaches, starting at page 6 line 11,

> Small variations in this delay [of the mixed and unwanted signals] are of no concern as these are eliminated by the adaptive canceler. However as the relative delay increases further, the adaptive canceler 30 will move towards one end of its range as imposed by the hardware implementation, i.e. the adaption will "move"

the centre of the filter along the filter hardware, reducing its effectiveness as it nears one end. For extreme variations in relative delay the adaption will attempt to move the filter beyond the end of its range and the required cancellation will not occur.

This problem is overcome by using the delay measuring system 10 to vary the compensating audio delays 21, 22 as changes in the relative delay of the incoming signals are detected. When small changes in delay are detected the system makes no compensation adjustment until the aggregate of these changes may affect the effectiveness of the adaptive cancellor 30. At this point the compensating audio delay could be changed inaudibly to match the new delay value and centre the adaptive canceller at the mid-point of its range (emphasis added).

A more detailed example of the operation of the adaptive cancellor in the presence of changing delay is given at the top of page 7, however no details of how the delays 21 and 22 are changed is found.

It is noted that Kirby states "the compensating audio delay could be changed inaudibly to match the new delay value and centre the adaptive canceller at the mid-point of its range". He does not actually state that this level of performance has been

achieved, or will even work with the embodiments of the invention he teaches. Kirby does recognize that it is important to make this change inaudibly, but does not describe or suggest how to do this. Questions arise as to what happens to the Adaptive Cancellation Circuit 30 when one of the delays 21 or 22 is changed.

While Kirby does recognize that it is important that "adaption operation is rapid and responsive to changes in the signals" he does not recognize or solve the delay change problem without interruption, nor does he describe how to overcome the problem of 30 needing to be recentered. Presumably either a delay change or a need to recenter 30 would require restarting Kirby's procedure, i.e. measuring the new delay, adjusting the delays 21 and 22, and readapting 30. In such an event, the delay times involved in at least the new adaptation of 30 would cause significant disruption of the performance, with highly undesirable consequences if such event occurred while the system was in use by some performer.

Kirby's three delay system is considerably different than applicant's system. When the relative timing of the mixed and unwanted signals changes - the delays 21 and 22 do not track the changing delay, rather Kirby adjusts his Adaptive Cancellation Circuit 30 (via delay 36) to accommodate those changes. When the delay change becomes large enough that "the aggregate of these changes may affect the effectiveness of the adaptive cancellor 30" then "At this point the compensating audio delay could be

changed inaudibly to match the new delay value and centre the adaptive canceller at the mid-point of its range".

The delays of Kirby's Unwanted Signal (22) and Mixed Signal (21) are adjusted to center the adaptive canceller range, rather than in response to the changing relative delay as in the instant invention. Kirby teaches that the delays 21 and 22 are used to minimize the size of 30.

It should be noted that Kirby's variable delay 21 serves to exacerbate the delay of mixed signal 14, which delay is at the cause of the problem in the first place (page 1, lines 6-10 of BACKGROUND OF THE INVENTION). Any residual unwanted signal which is left in the mixed signal output 34 will thus be further delayed with respect to 14, aggregating the problem.

Additionally, Kirby's invention, due to its complexity apparently has some shortcomings with tracking large delay variations and has long adaption times. Kirby does recognize these shortcomings which he attempts to overcome by making his invention more complex as shown and described with respect to his Figure 5. The Figure 5 embodiment is "able to track large variations in the relative delay" and avoids "the longer adaption times" (page 8, ¶ 4).

Applicant's invention on the other hand does not further delay the feedback signal. Applicant's invention adjusts the delay of the talent signal in response to changing delay or

relative timing as shown by way of example in Figure 2 where 16 measures the relative delay or timing and controls the delay 12 and gain 14 of the talent signal from 10. Applicant's invention does away with the need to delay the feedback signal 18, and can track changes in the relative delay of 10 and 18 by directly changing the amount of delay of 12. In addition, applicant's invention provides for changing the amplitude of the talent signal via 14, thereby obviating the need for Kirby's adaptive filter 32 and delay 36 of the complex adaptive cancellation circuit 30. In short, applicant's invention is simpler, has fewer parts and works better.

These features are brought out in the claims, for example Claim 1 recites "to delay said talent signal in a variable delay in response to said varying amount of delay. Claim 2 recites "delay said talent signal in a variable delay by an amount responsive to said varying relative timing". Claim 3 recites "a variable delay by an amount responsive to said relative delay which may vary".

Other patentable distinctions are also present in the instant invention. For example, Kirby does not adjust the gain or phase of the talent signal (in delayed or undelayed form) in response to the operator, mix minus signal or program signal as described, for example at the second paragraph of page 7. Kirby does not automatically operate to determine the talent signal

component of the program signal and adjust the amplitude and delay of the cancellation signal (¶2, p7). The present invention may be responsive to both program and mix minus signals to determine delay in response to one and amplitude in response to the other (¶3, p7). Several other patentable distinctions are described throughout the specification.

In that the application as presently amended is believed in condition for allowance, favorable action in that respect is earnestly solicited.

Respectfully submitted,

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